

able for use with multi-layer displays available from Deep Video Imaging™ include Appian Graphics, ATI Technologies, Inc, Matrox, nVidia, and Peritek Corporation for the Microsoft® Windows®, Apple® Macintosh®, Linux, BeOS, OS/2, and Solaris™ operating system platforms.

[0117] In another embodiment, a multi-layer display includes three liquid crystal layers which are independently controlled by a CPU such as CPU 104 in FIG. 1. An infrared or imaging device is mounted on the cabinet of a gaming machine, and is controlled by a controller such as CPU 104 in FIG. 1 to track a characteristic associated with a player, such as the player's position, angle, or movement. The controller uses the position and movement information provided by the infrared or imaging device to manipulate the three liquid crystal layers creating a 3D effect regardless of the angle at which the player is viewing the display. In addition, a 3D motion effect can be created as a player moves. For example, to "see" around an object, a player might move his head to the left or right, and as he does, the graphics displayed on the three layers are conventionally adjusted so that the imagery obscured by the object from one angle become visible to the player when viewed from the new angle. In addition, previously obscured details of the object may also be made visible (motion parallax), thus more closely approximating real-world observation of 3D objects.

[0118] In an embodiment, the infrared or imaging device is also used to track the time a player is in front of the gaming machine. The gaming machine also keeps track of the player's interaction with the wagering game, and combines the data from the infrared or imaging device to calculate the "time played" and "time wasted" by a player for demographics studies, and the like. For example, this tracking feature may be exploited in a new wagering game to assess its attractiveness to players before full-scale release.

[0119] Although a two- and three-layer multi-layer display has been described herein, the present invention also contemplates any multi-layer display having more than three layers.

[0120] C. Holographic Display

[0121] A third type of true 3D display is holographic display, also known as a holovideo display. Displaying a 3D holographic image generally requires two processes, a computational process in which a 3D description is converted into a holographic fringe pattern, and an optical process in which light is modulated by the fringe to produce a 3D image.

[0122] The computational process involves a rendering stage and a holographic fringe generation stage. The rendering stage involves spatially transforming polygons, lighting, occlusion processing, shading, and in some cases, rendering to 2D images. Note that if the 3D description already exists as 3D voxels, the rendering stage is unnecessary. The fringe generation stage computes a 2D holographic fringe based on the data from the rendering stage. These two computing stages can be linked under an interference-based or diffraction-specific approach, both of which are known in the art.

[0123] The second process is optical modulation and processing. Two holographic modulation techniques are illus-

trated in FIGS. 14a and 14b, though all other techniques known in the art are contemplated by the present invention. FIG. 14a is a functional block diagram of a holographic optical modulation technique using a high-resolution spatial light modulator (SLM), and FIG. 14b is a functional block diagram of a holographic optical modulation technique using a scanned acousto-optic modulator (AOM).

[0124] The SLM-based holographic optical modulation technique uses an optical modulation assembly 1400a which generally includes a computer 1402a, a high-resolution SLM 1404a, and a demagnification lens 1406a. The holographic fringe patterns generated in the computational process are provided by the computer 1402a to the SLM 1404a. The digital data provided by the computer 1402a is converted to corresponding photons by modulating light with a computed holographic fringe using the SLM 1404a. The modulated photons are passed through the demagnification lens 1406a to compensate for the disparity between the fringe sampling pitch (typically about 0.5 microns wide) and the modulation elements in the SLM (typically about 50 microns wide). In an embodiment, the SLM 1404a is a liquid crystal display, which operates as a phase modulator. In another embodiment, the SLM 1404a is a deformable micro-mechanical mirror device. The de-magnified, modulated photons display a 3D image 1408a to a viewer 1410a.

[0125] The AOM-based holographic optical modulation technique uses an optical modulation assembly 1400b which generally includes a computer 1402b, an AOM 1408b, an imaging lens 1410b, a vertical scanner 1412b, a horizontal scanning system 1414b, and an output lens 1416b. The computed fringes stored in the high-speed frame buffers 1404b of the computer 1402b are RF processed in an RF signal broadcasting system 1406b to traverse the wide aperture of the AOM 1408b as acoustic waves. The AOM 1408b phase-modulates a beam of laser light into diffracted light which is imaged and de-magnified by the imaging lens 1410b and output lens 1416b, respectively, at a plane in front of a viewer 1420b. The horizontal scanning system 1414b angularly multiplexes the image of the modulated light, and a vertical scanning mirror 1422b reflects diffracted light to the correct vertical position in the hologram plane. In an embodiment, the AOM 1408b is a three-channel (R,G,B) tellurium-dioxide Acousto-Optic Modulator.

[0126] Holographic displays are available from at least Icon International Images, Inc., d/b/a 3Dmirage, and King-maker in the United Kingdom. Other holographic displays, such as the Mark-I and the Mark-II, have been developed by the Spatial Imaging Group at the MIT Media Lab.

[0127] FIG. 15 is a perspective view of a gaming machine 1500 having a holographic display 1502 that displays a 3D holographic image 1508 through a lens 1506. The holographic image 1508 is part of the Reel'em In!® bonus game described in connection with FIG. 3. Note that the player could actually pass a hand through the holographic image 1508. In another embodiment, the holographic image is projected onto a holographic film. A secondary display 1504 may display the second part of a unified image associated with a bonus game or it may display a basic game or a help/information screen.